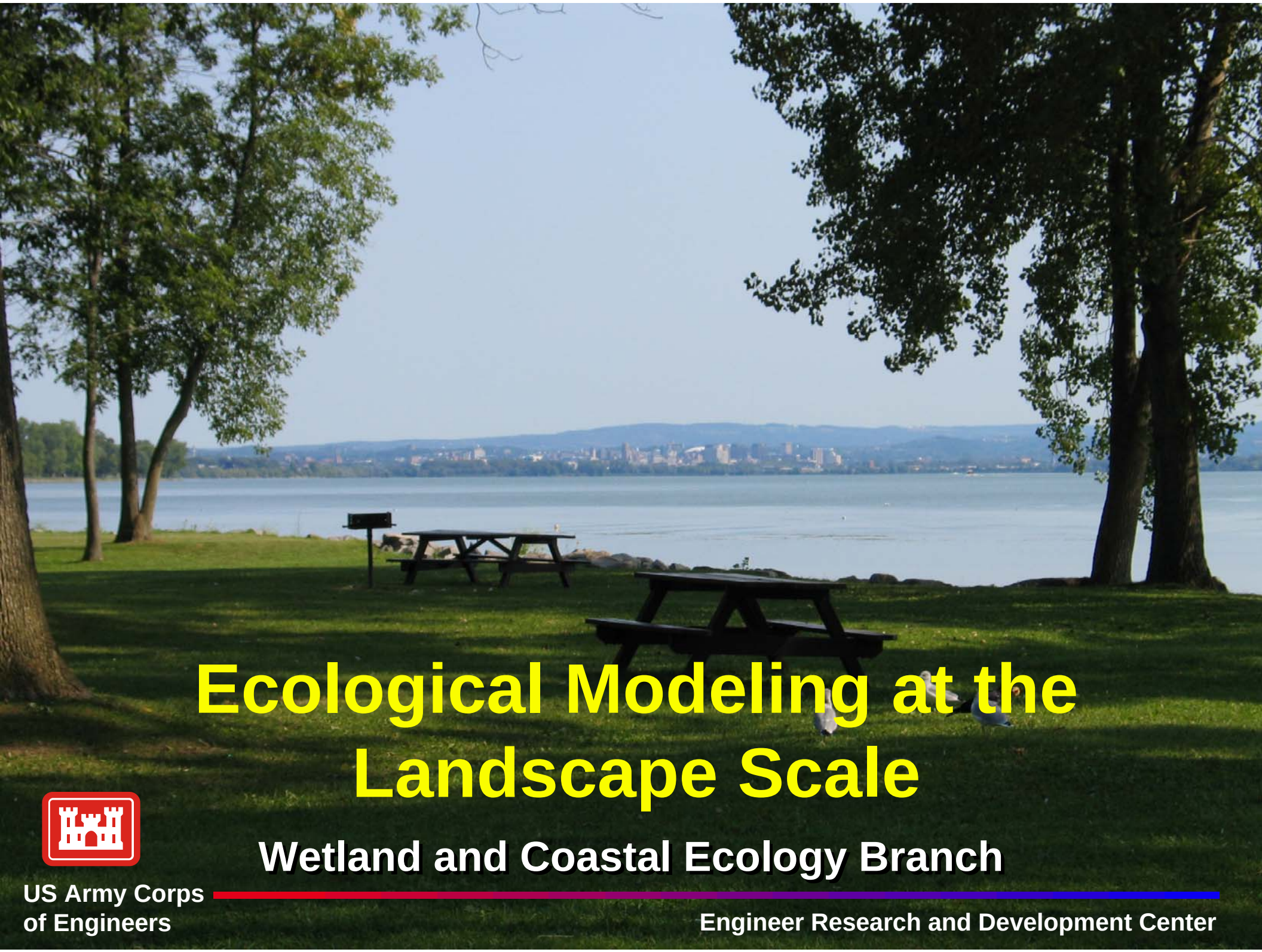


Ecological Modeling at the Landscape Scale

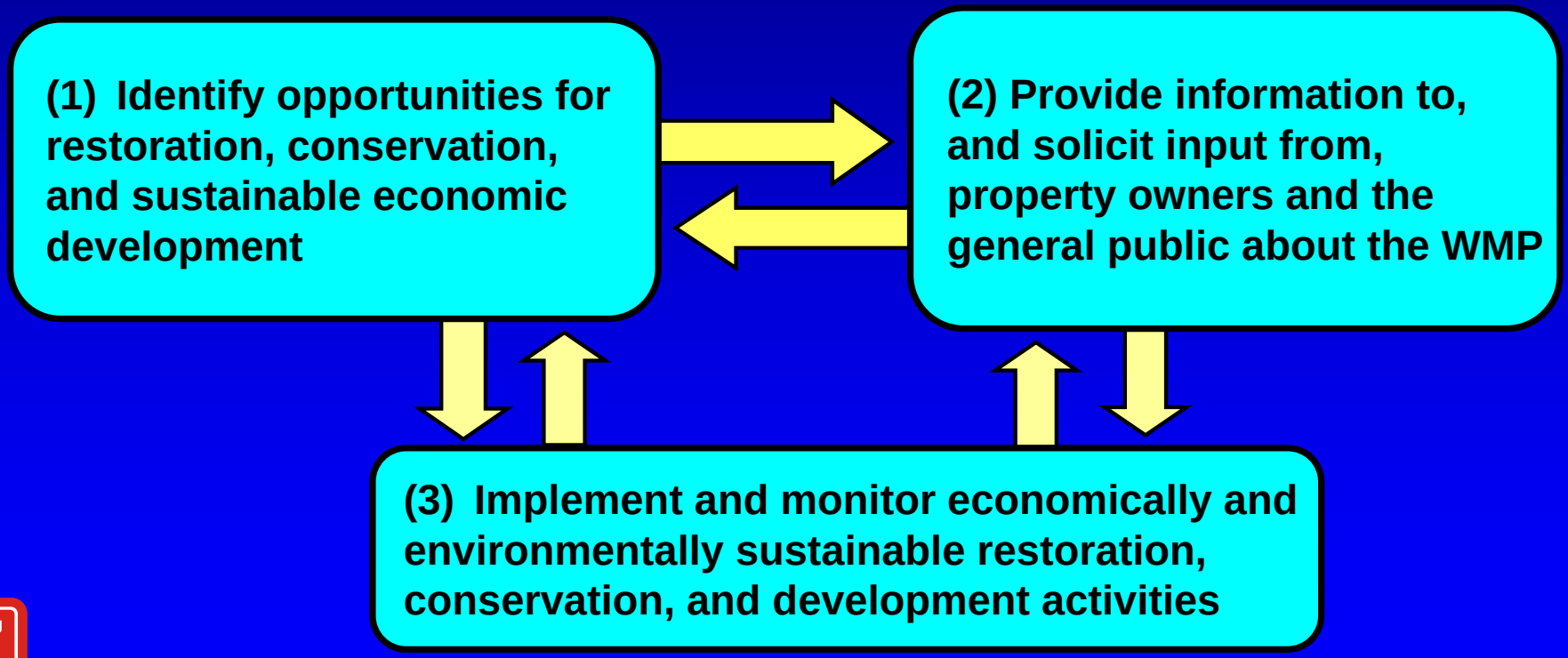
Wetland and Coastal Ecology Branch

US Army Corps of Engineers

Engineer Research and Development Center

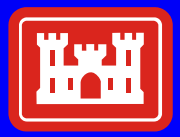
MAWI – Multi-scale Assessment of Watershed Integrity

- **Goal: Provide a suite of tools that can be used to…**

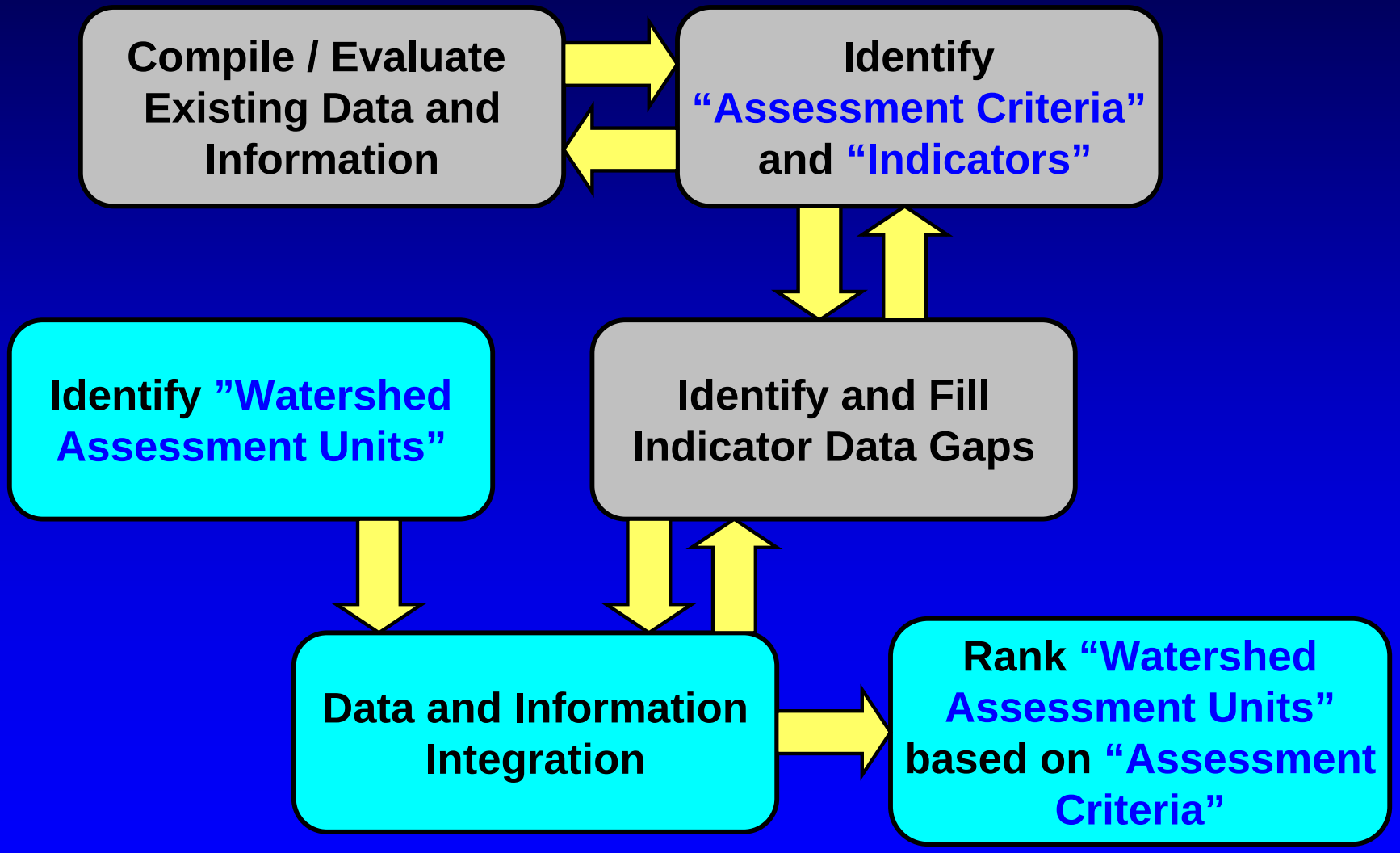


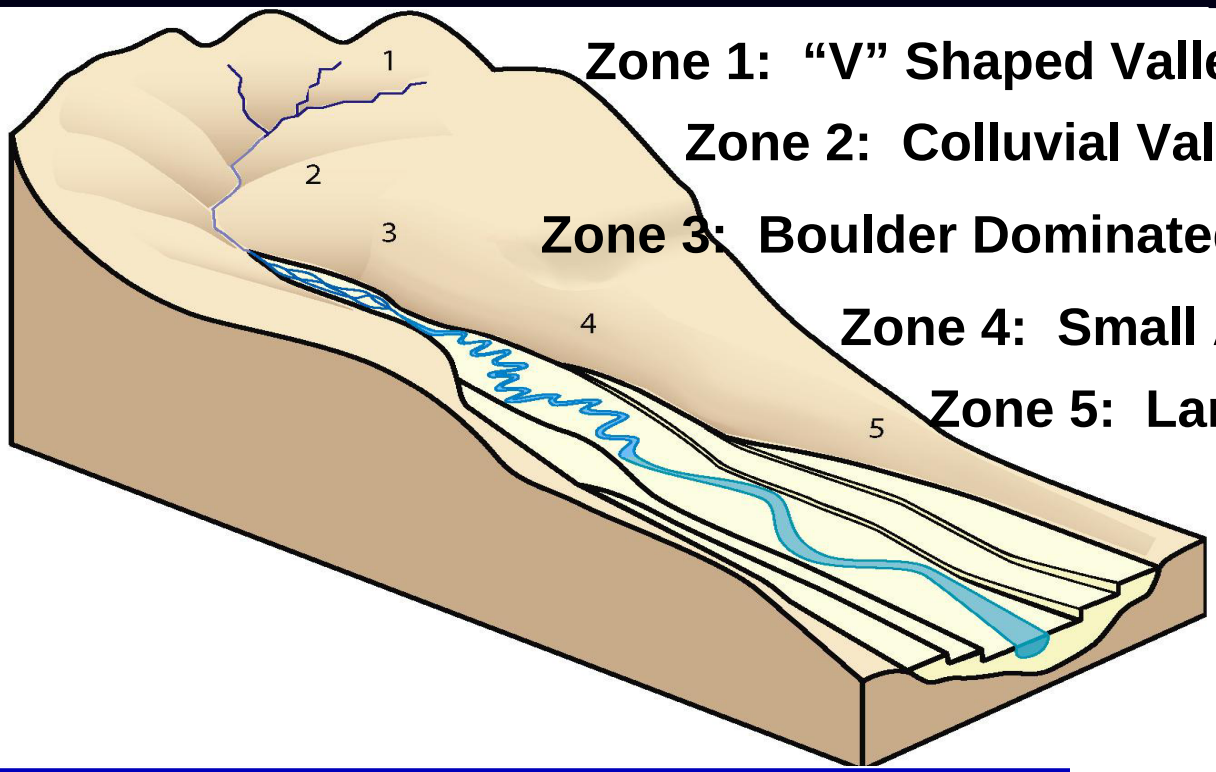
MAWI

- Multi-scale Assessment of Watershed Integrity (MAWI)
  - Spatial Decision Support System
  - Uses multiple scales, assesses multiple disciplines
  - Involves field sampling
  - Serves as a baseline assessment and focusing tool
  - Has previously been applied throughout California, being developed for western New York and Indiana



Baseline Watershed Assessment Tasks





Zone 1: "V" Shaped Valleys

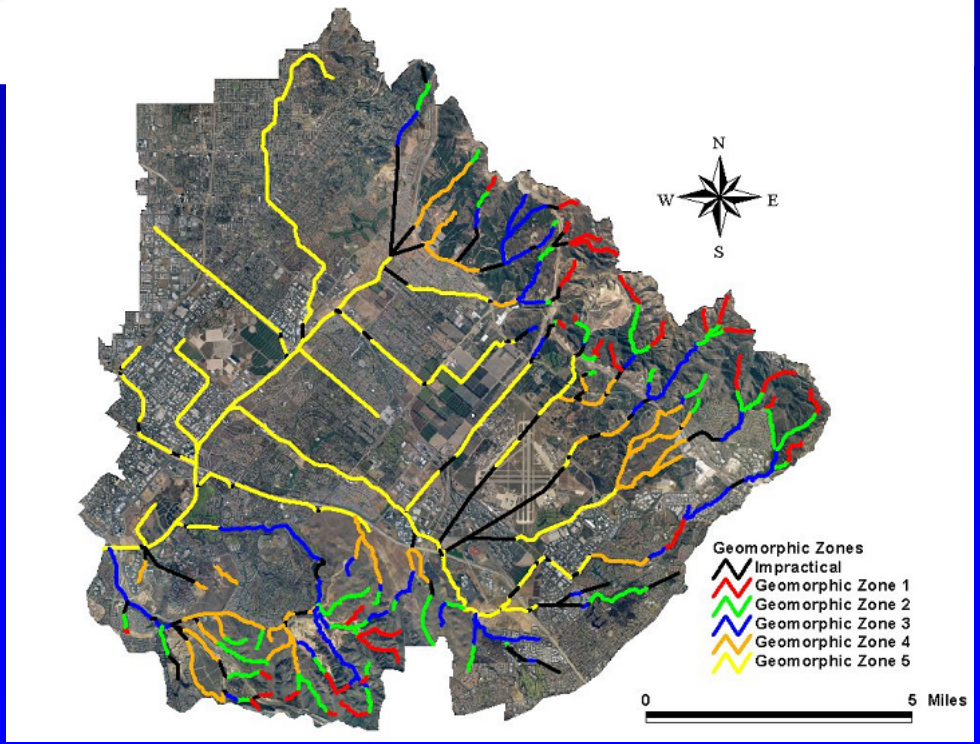
Zone 2: Colluvial Valleys

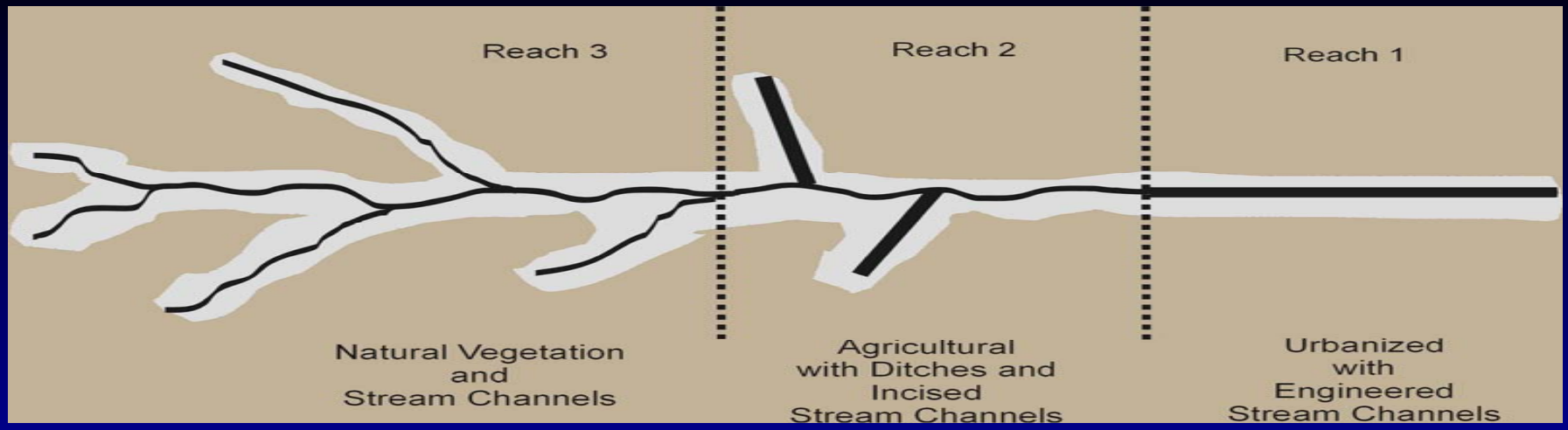
Zone 3: Boulder Dominated Floodplain/Terrace Complexes

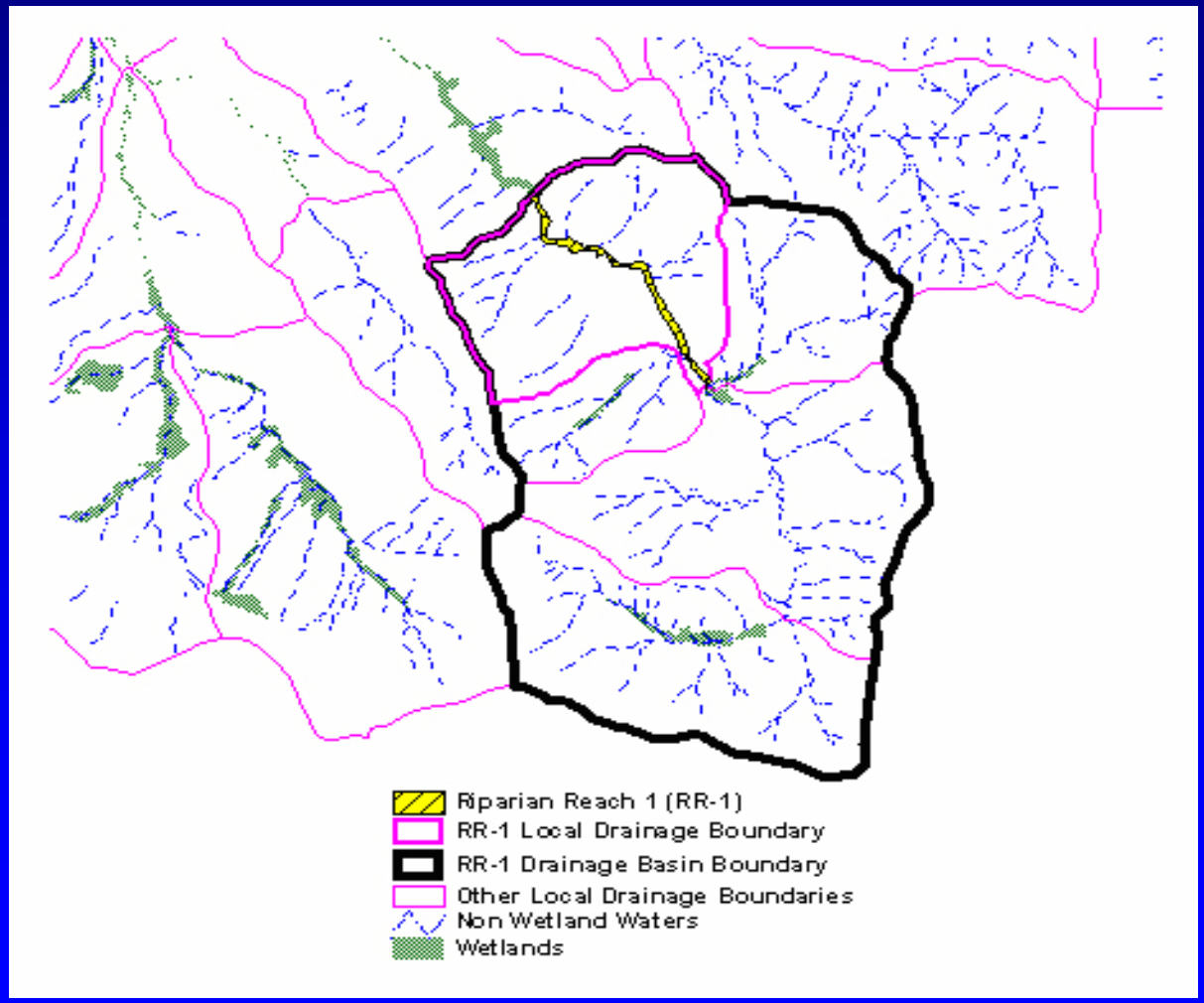
Zone 4: Small Alluvial Valleys

Zone 5: Large Alluvial Valleys

- Geomorphic zone assignment
  - Critical to restoration planning



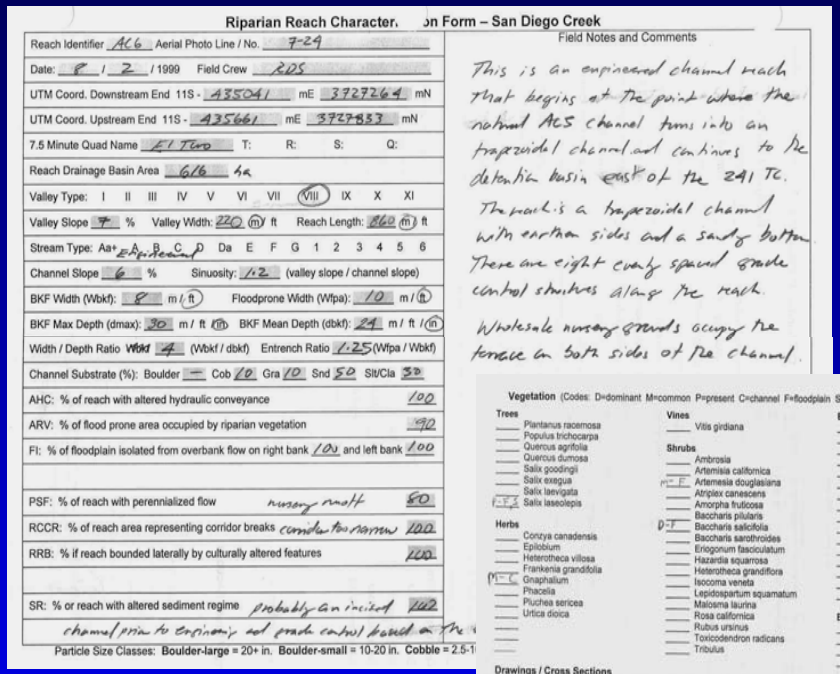




- Assessment Units
  - Stream reaches
  - Local Drainages
  - Drainage Area

Watershed Assessment – Reach Evaluation

- **Field work at the riparian reach scale included:**
  - Assessing reach scale indicators
  - Characterizing the riparian reach in representative locations in terms of:
    - Stream type, geometry, and substrate
    - Dominant vegetation
    - Sediment regime
    - Cultural alteration
    - Other factors
- **This information was utilized to develop riparian reach restoration templates**



Riparian Reach Character... on Form – San Diego Creek

Reach Identifier AC6 Aerial Photo Line / No. 7-24

Date: 8 / 2 / 1999 Field Crew RDS

UTM Coord. Downstream End 11S - 435041 mE 3727264 mN

UTM Coord. Upstream End 11S - 435661 mE 3727833 mN

7.5 Minute Quad Name El Toro T: R: S: Q:

Reach Drainage Basin Area 616 ha

Valley Type: I II III IV V VI VII (VIII) IX X XI

Valley Slope 7 % Valley Width: 220 (m) / ft Reach Length: 860 (m) / ft

Stream Type: Aa+ A B C D Da E F G 1 2 3 4 5 6 Engineered

Channel Slope 6 % Sinuosity: 1.2 (valley slope / channel slope)

BKF Width (Wbkf): 8 m / (ft) Floodprone Width (Wfpa): 10 m / (ft)

BKF Max Depth (dmax): 30 m / ft / (in) BKF Mean Depth (dbkf): 24 m / ft / (in)

Width / Depth Ratio Wbkf 4 (Wbkf / dbkf) Entrench Ratio 1.25 (Wfpa / Wbkf)

Channel Substrate (%): Boulder — Cob 10 Gra 10 Snd 50 Slt/Cla 30

AHC: % of reach with altered hydraulic conveyance 100

ARV: % of flood prone area occupied by riparian vegetation 90

FI: % of floodplain isolated from overbank flow on right bank 100 and left bank 100

PSF: % of reach with perennialized flow nursery runoff 80

RCCR: % of reach area representing corridor breaks corridor too narrow 100

RRB: % if reach bounded laterally by culturally altered features 100

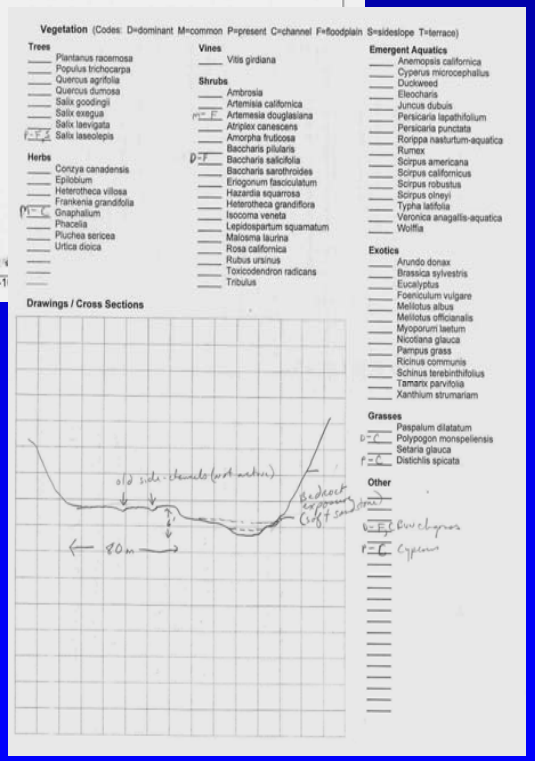
SR: % or reach with altered sediment regime probably an incised 100

channel prior to engineering and grade control based on the

Particle Size Classes: Boulder-large = 20+ in. Boulder-small = 10-20 in. Cobble = 2.5-1

Field Notes and Comments

This is an engineered channel reach that begins at the point where the natural AC5 channel turns into an trapezoidal channel and continues to the detention basin east of the 241 TC. The reach is a trapezoidal channel with earthen sides and a sandy bottom. There are eight evenly spaced grade control structures along the reach. Wholesale nursery grounds occupy the terrace on both sides of the channel.



Vegetation (Codes: D=dominant M=common P=present C=channel F=floodplain S=sideslope T=terrace)

Trees: Plantanus racemosa, Populus trichocarpa, Quercus agrifolia, Quercus dumosa, Salix goodingii, Salix exegua, Salix laevigata, F-F,S Salix laseolepis

Herbs: Conzya canadensis, Epilobium, Heterotheca villosa, Frankenia grandifolia, M-C Gnaphalium, Phacelia, Pluchea sericea, Urtica dioica

Vines: Vitis girdiana

Shrubs: Ambrosia, Artemisia californica, M-F Artemesia douglasiana, Atriplex canescens, Amorpha fruticosa, Baccharis pilularis, D-F Baccharis salicifolia, Baccharis sarothroides, Eriogonum fasciculatum, Hazardia squarrosa, Heterotheca grandiflora, Isocoma veneta, Lepidospartum squamatum, Malosma laurina, Rosa californica, Rubus ursinus, Toxicodendron radicans, Tribulus

Emergent Aquatics: Anemopsis californica, Cyperus microcephallus, Duckweed, Eleocharis, Juncus dubuis, Persicaria lapathifolium, Persicaria punctata, Rorippa nasturtum-aquatica, Rumex, Scirpus americana, Scirpus californicus, Scirpus robustus, Scirpus olneyi, Typha latifolia, Veronica anagallis-aquatica, Wolffia

Exotics: Arundo donax, Brassica sylvestris, Eucalyptus, Foeniculum vulgare, Melilotus albus, Melilotus officianalis, Myoporum laetum, Nicotiana glauca, Pampus grass, Ricinus communis, Schinus terebinthifolius, Tamarix parvifolia, Xanthium strumariam

Grasses: Paspalum dilatatum, D-C Polypogon monspeliensis, Setaria glauca, P-C Distichlis spicata

Other: D-F,C Bow chapras, P-C Cyperus

Drawings / Cross Sections

old side-channels (not active)

Bedrock exposure (soft sandstone)

80 m

Example Data Collected for Reach Characteristics for MAWI

Size of Local Drainage Area	GIS
Valley Type (Rosgen)	Field
Valley Width (m)	Field/GIS
Downstream End Elevation	GIS
Valley Slope	GIS
Mainstem Channel Length	GIS
Drainage Density	Calculated
Bankful Width	Field
Natural Channel Substrate	Field
% of LULC contributing nutrients	GIS

Assessment Criteria

- Criteria are the standards that can be used to make judgments or decisions concerning restoration, conservation and sustainable economic development
- For example:

  What is the condition of salmonid habitat?

  What is the level of human disturbance?

  Has water quality in a stream reach been comprised?

  What is the extent and condition of riparian habitat?

  Has the hydrologic regime in a stream reach been altered?

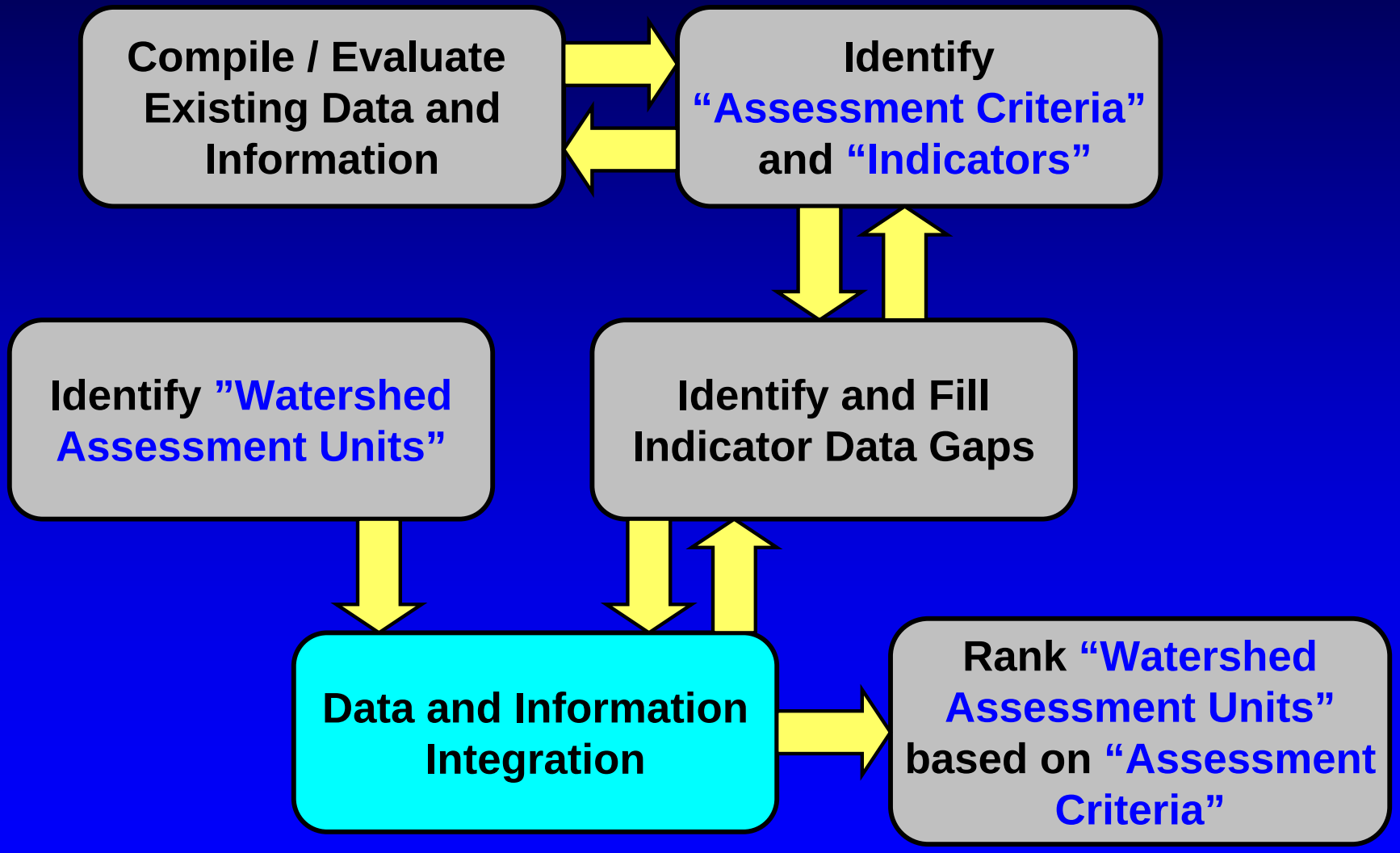
  What is the erosion or landslide potential in a drainage basin?

Watershed Component	Assessment Criteria	Critical Issue Identified in POA
Uplands	Groundwater Condition	CI-7
	Land Use / Land Cover Condition	CI-9, CI-10, CI-11, CI-12, CI-13
	Upland Erosion / Surface Runoff Condition	CI-10, CI-11, CI-12, CI-13, CI-21, CI-28
	Point Source Condition	CI-22, CI-24, CI-27
	Forestry Practices Condition	CI-25
	Road Culvert Condition	CI-26
Riparian	Vegetation Condition	CI-1
	Woody Debris Condition	CI-1
	Exotic Vegetation Condition	CI-5
	Corridor Width and Continuity Condition	CI-1
Streams	Water Temperature Condition	CI-2, C-23
	Geomorphic Condition	CI-3
	Sediment / Substrate Condition	CI-4, CI-20
	Habitat Condition - General	CI-6
	Habitat Condition - Migration and Spawning	CI-8
	Surface Water Quantity Condition - General	CI-14, CI-15, CI-16, CI-17, CI-18
	Surface Water Quantity Condition - Salmonids	CI-19
	Surface Water Quality Condition	CI-20, CI-21, CI-24

Indicators

- Indicators are measures designed to quickly and easily communicate information about the current condition of something of interest, and over time, about changes or trends in the condition
- For example:
  - Dow Jones Industrial Average or Body Mass Index
  - Land use / cover
  - Riparian canopy density and composition
  - Density of roads and road crossings
  - Percent of pools in a stream reach
  - Presence of invasive exotic species
  - Upland fauna diversity and abundance
  - Soil erodibility

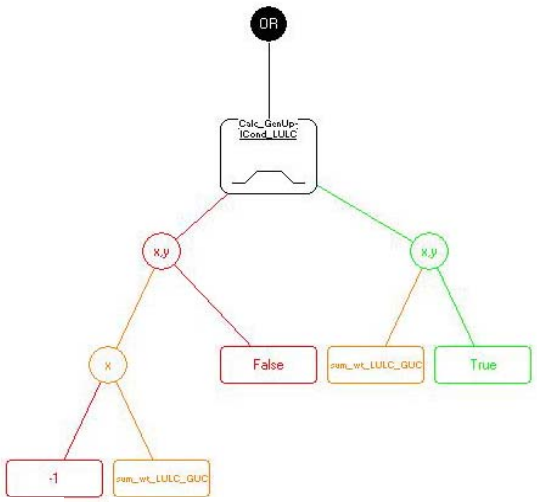
Baseline Watershed Assessment Tasks

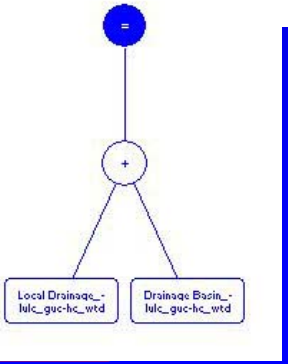


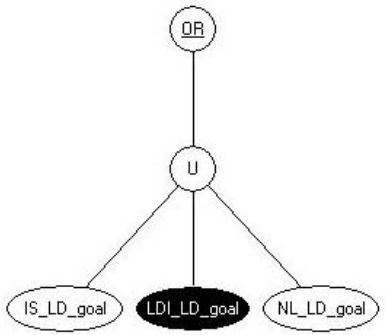
FY 06 Product Development

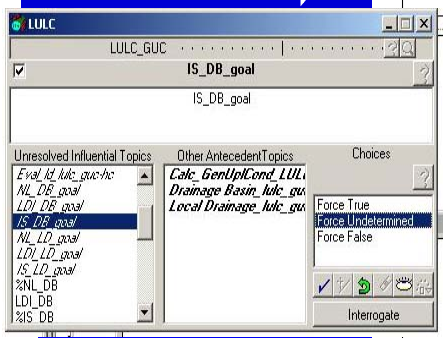
NetWeaver

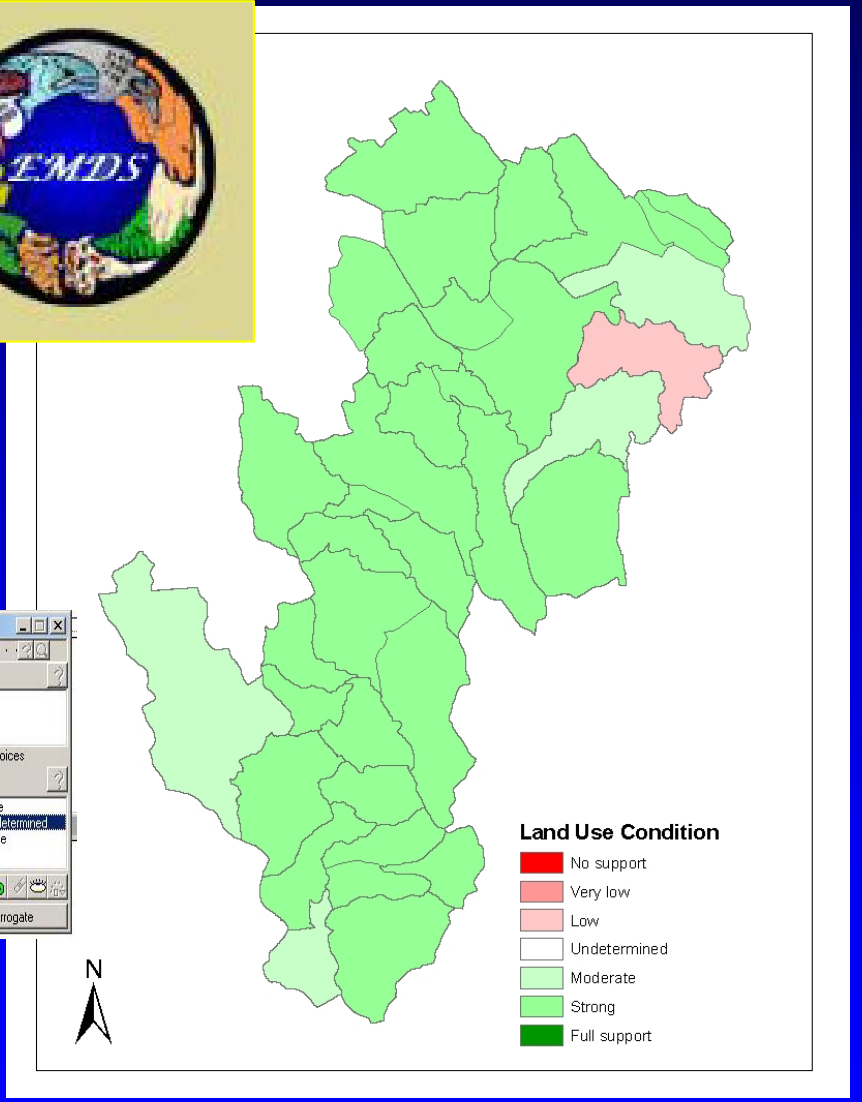
EMDS





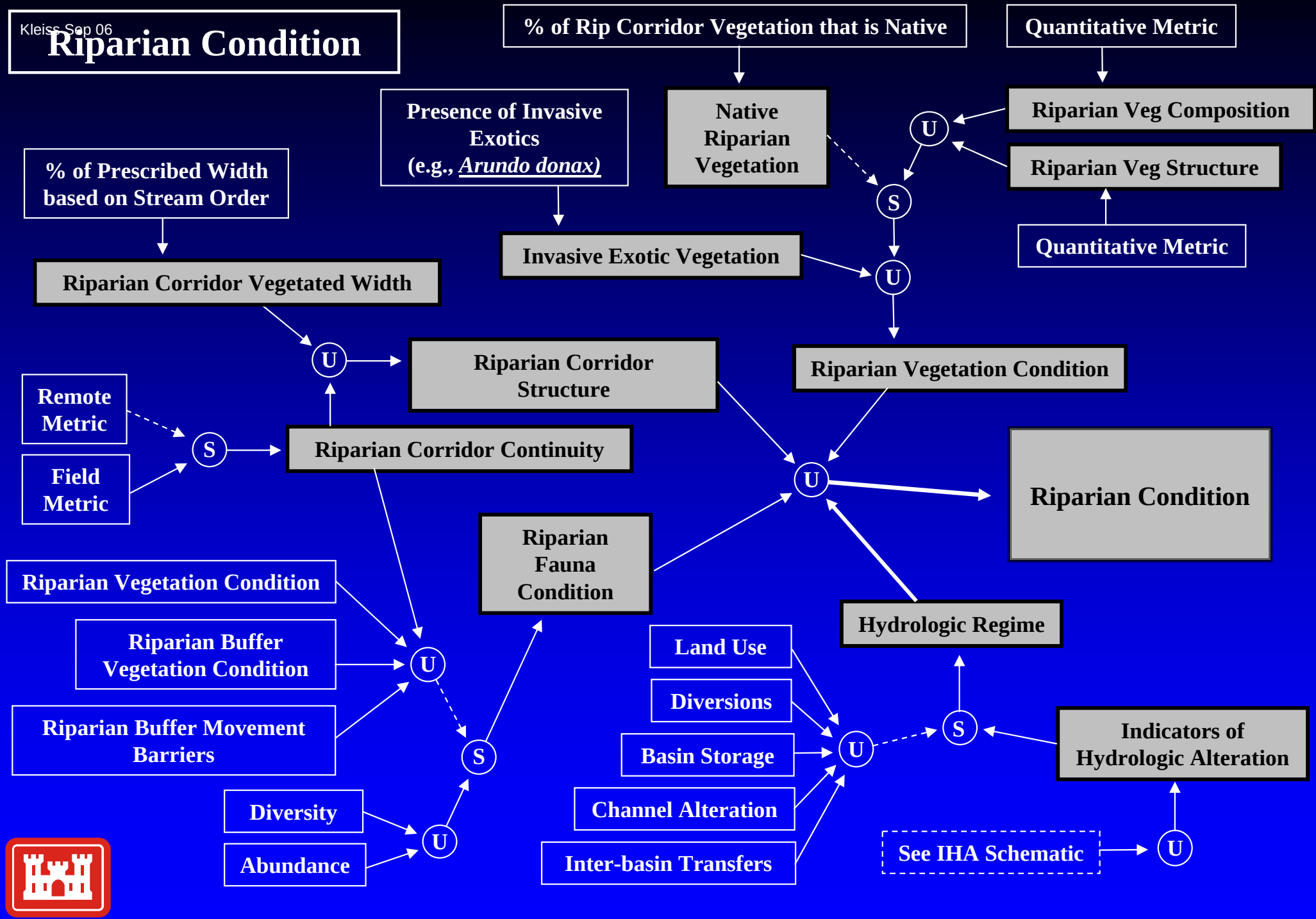


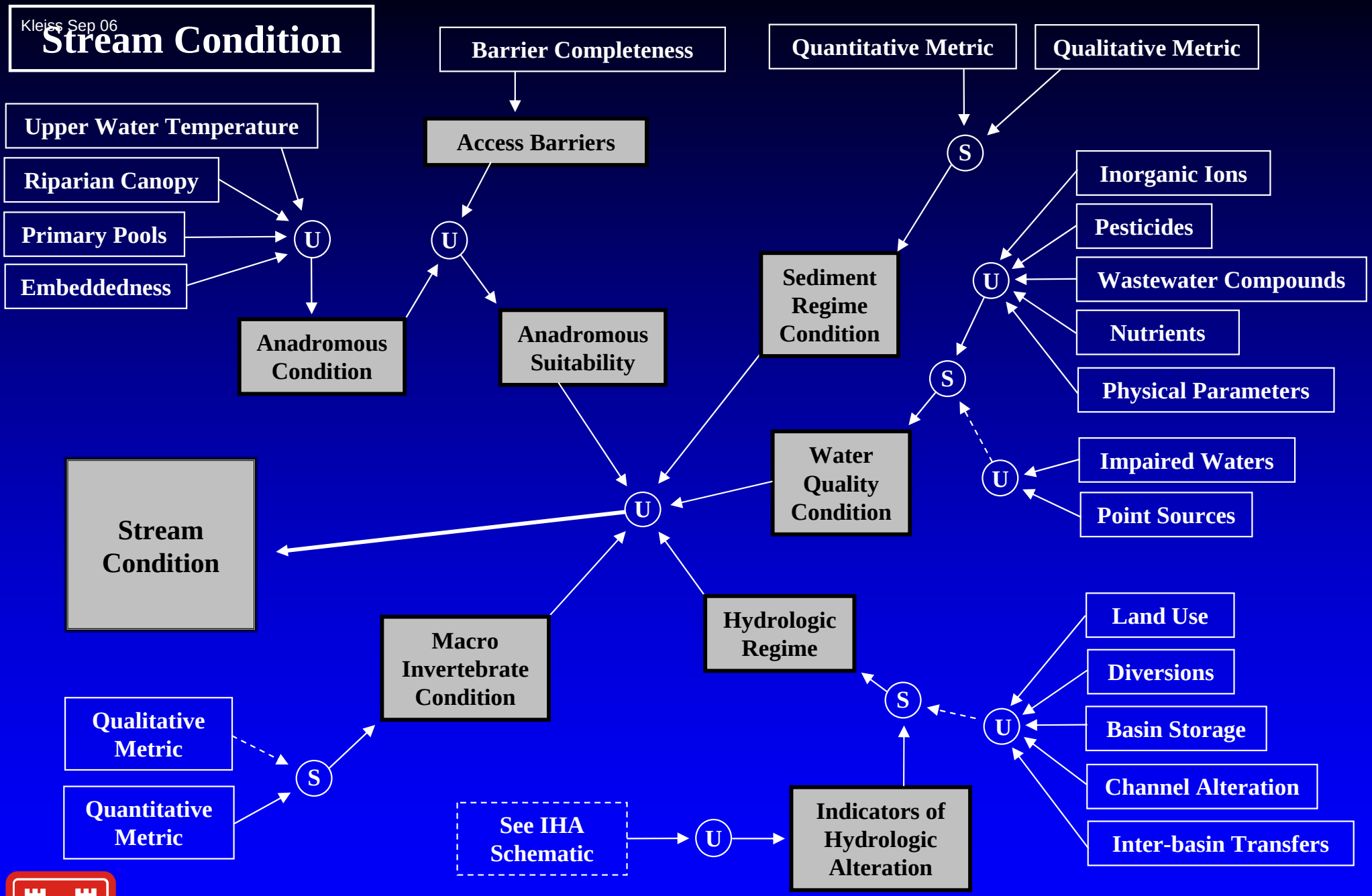


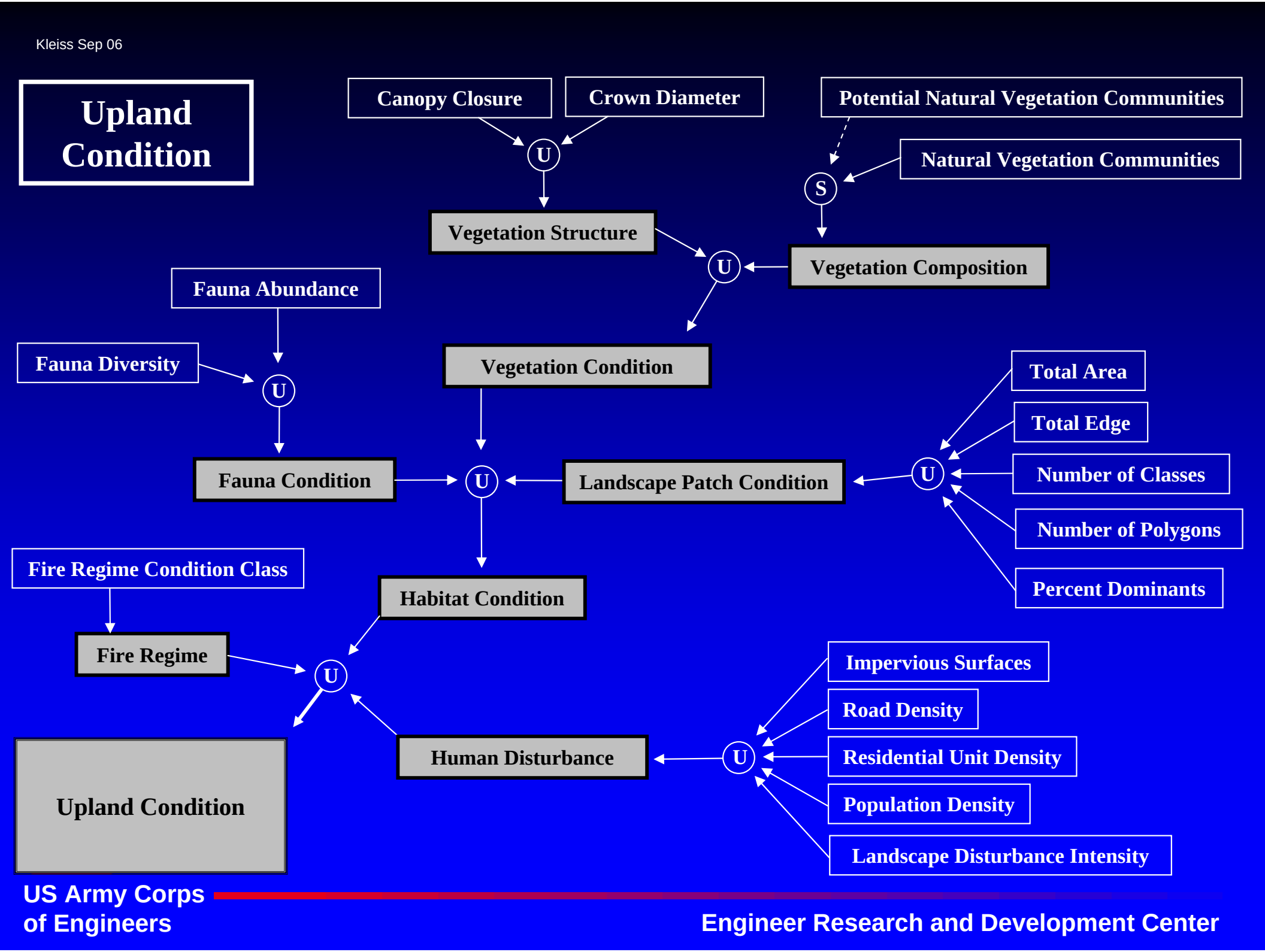


Kleiss Sep 06

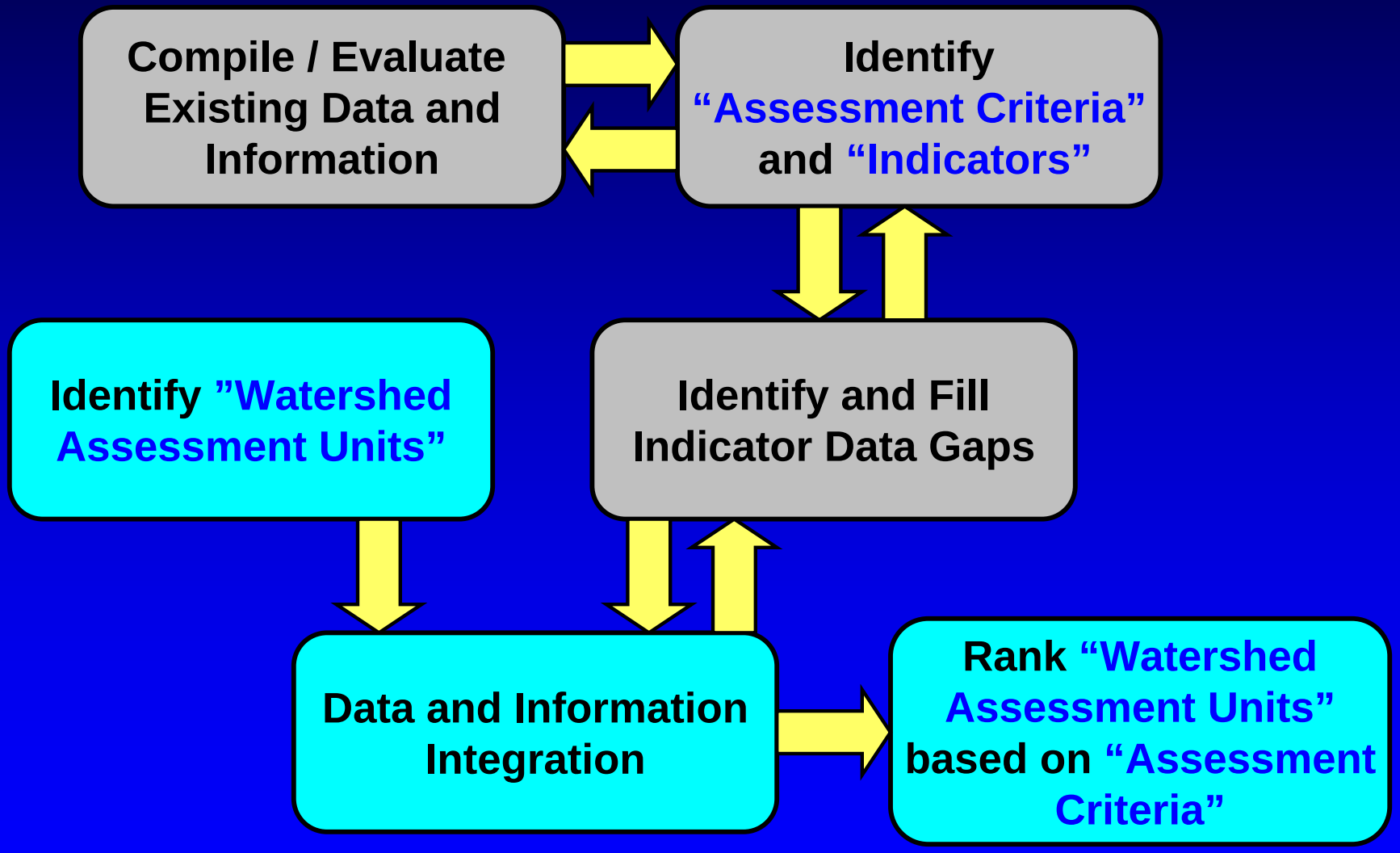
Riparian Condition

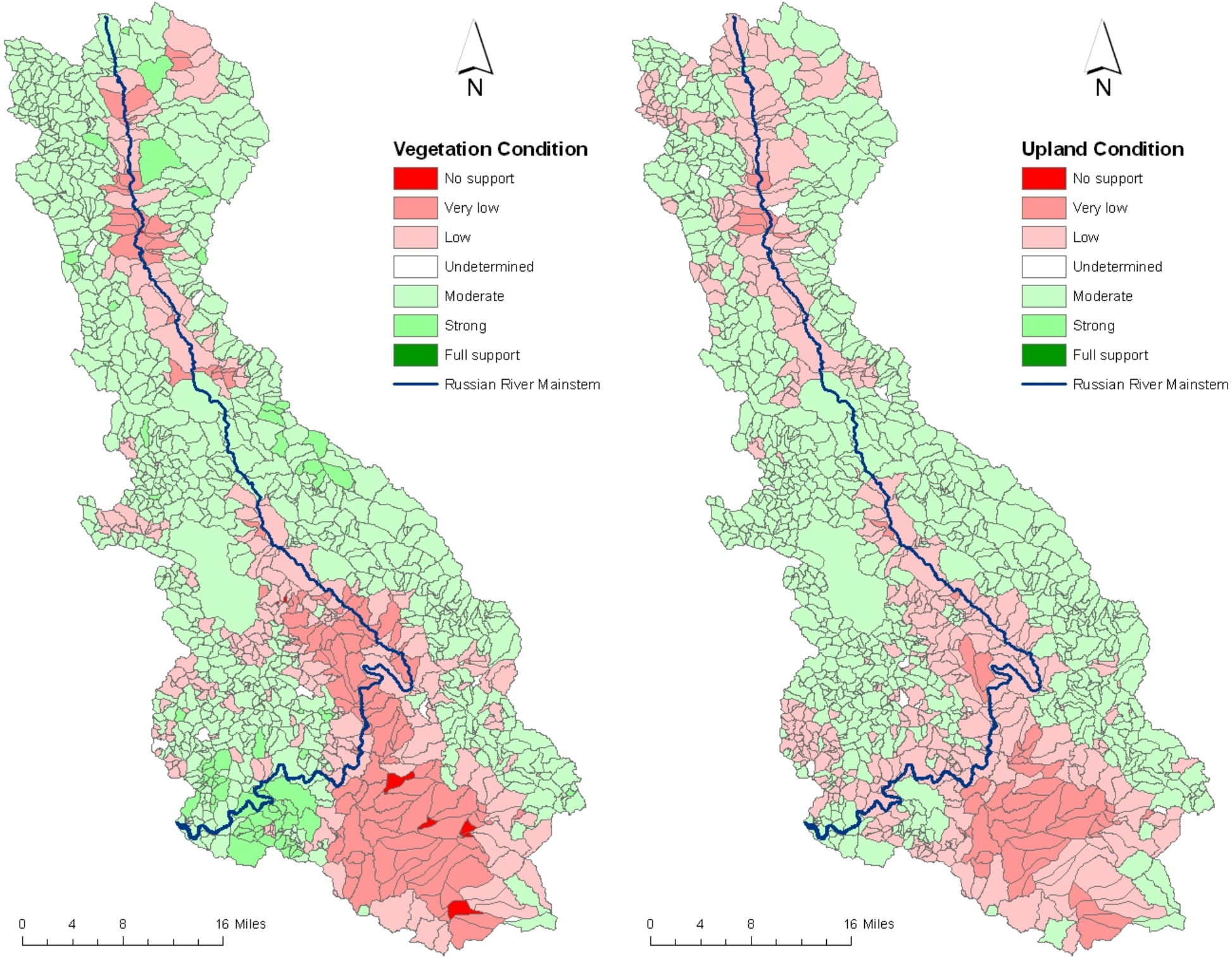


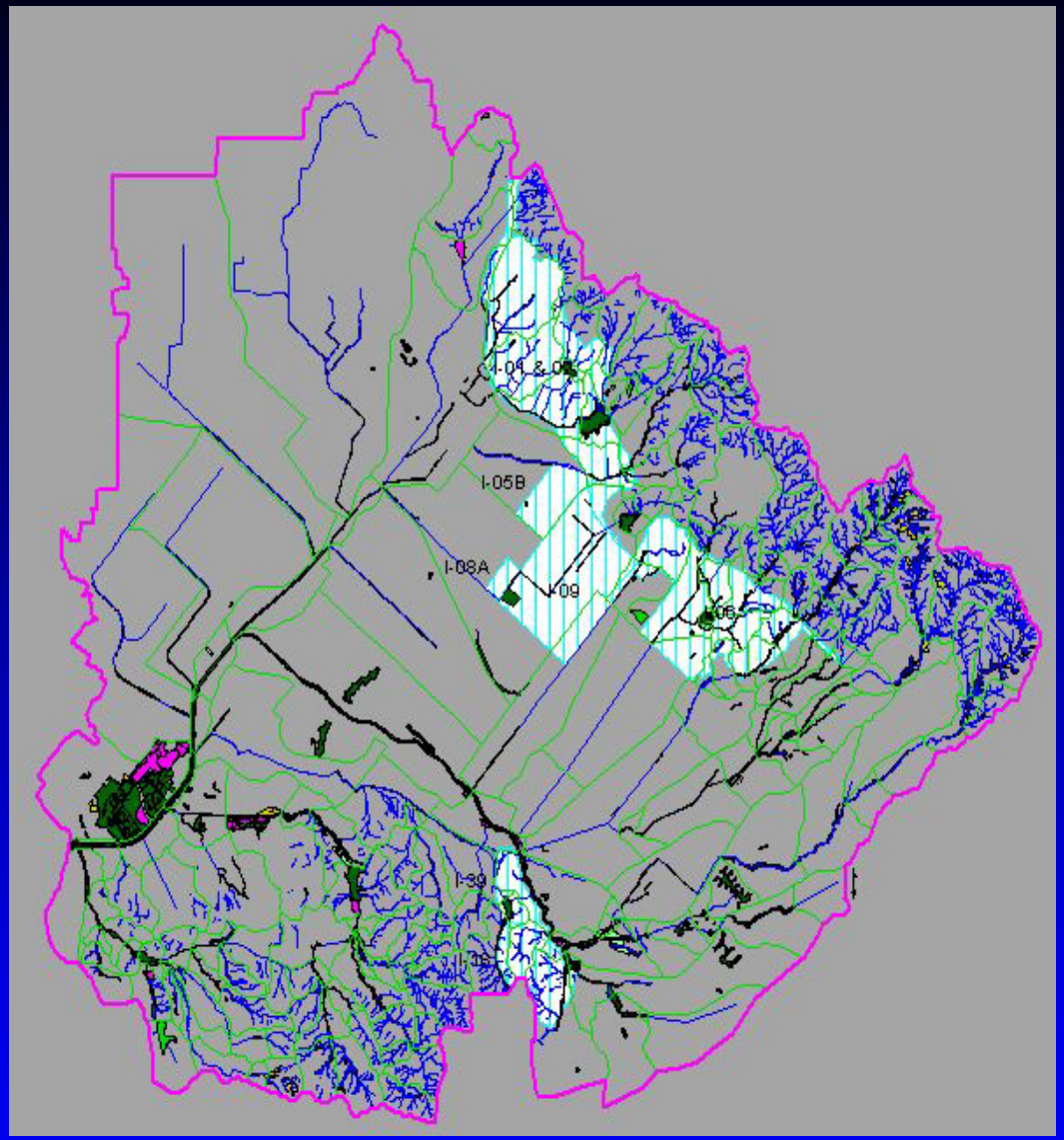

Stream Condition
Barrier Completeness
Quantitative Metric
Qualitative Metric
Upper Water Temperature
Riparian Canopy
Primary Pools
Embeddedness
Access Barriers
S
Inorganic Ions
Pesticides
Wastewater Compounds
Nutrients
Physical Parameters
U
Anadromous Condition
Anadromous Suitability
Sediment Regime Condition
Water Quality Condition
Impaired Waters
Point Sources
Stream Condition
Macro Invertebrate Condition
Hydrologic Regime
Land Use
Diversions
Basin Storage
Channel Alteration
Inter-basin Transfers
Qualitative Metric
Quantitative Metric
See IHA Schematic
Indicators of Hydrologic Alteration


Upland Condition
Canopy Closure
Crown Diameter
U
Potential Natural Vegetation Communities
Natural Vegetation Communities
S
Vegetation Structure
U
Vegetation Composition
Fauna Abundance
Fauna Diversity
U
Vegetation Condition
Total Area
Total Edge
Number of Classes
Number of Polygons
Percent Dominants
Fauna Condition
U
Landscape Patch Condition
U
Fire Regime Condition Class
Habitat Condition
Fire Regime
U
Impervious Surfaces
Road Density
Residential Unit Density
Population Density
Landscape Disturbance Intensity
Human Disturbance
U
Upland Condition

Baseline Watershed Assessment Tasks

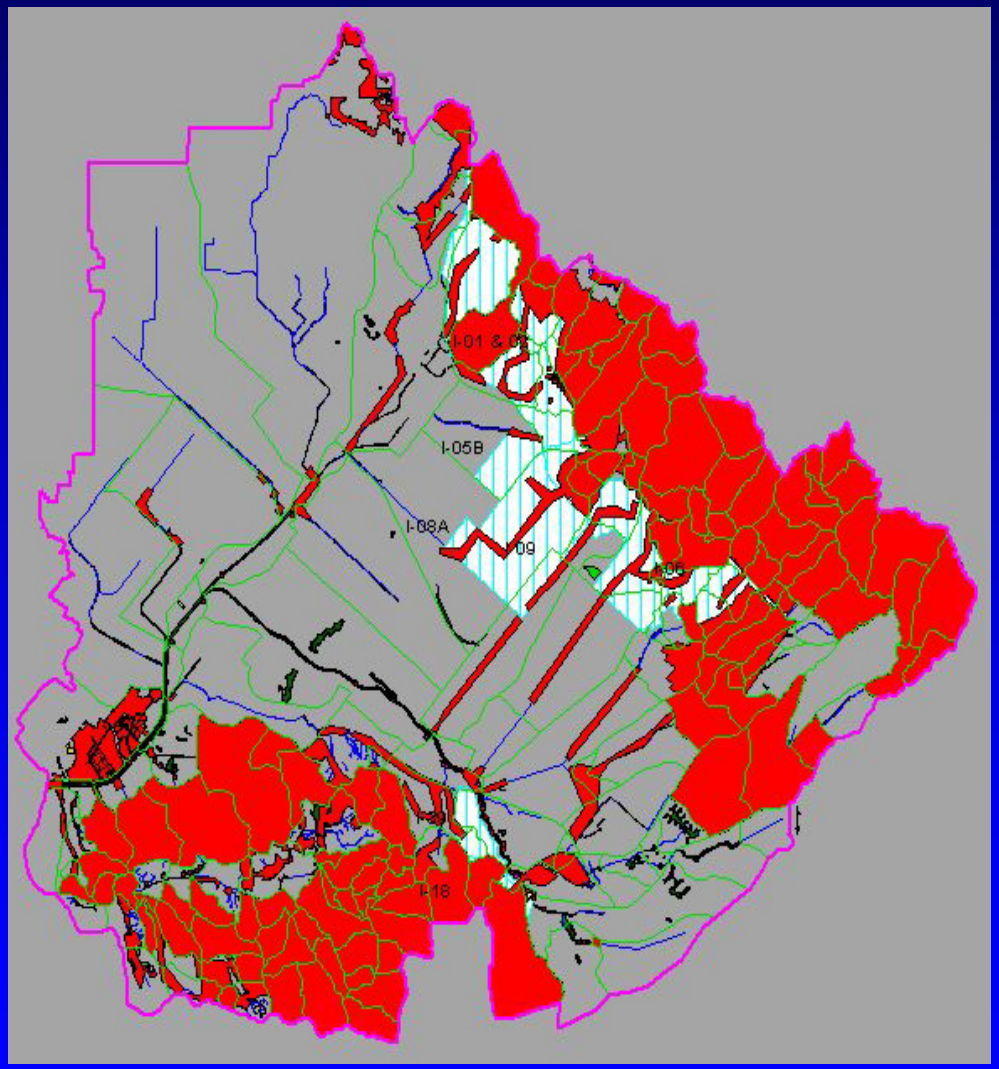



N
Vegetation Condition
No support
Very low
Low
Undetermined
Moderate
Strong
Full support
Russian River Mainstem
0
4
8
16 Miles
N
Upland Condition
No support
Very low
Low
Undetermined
Moderate
Strong
Full support
Russian River Mainstem
0
4
8
16 Miles



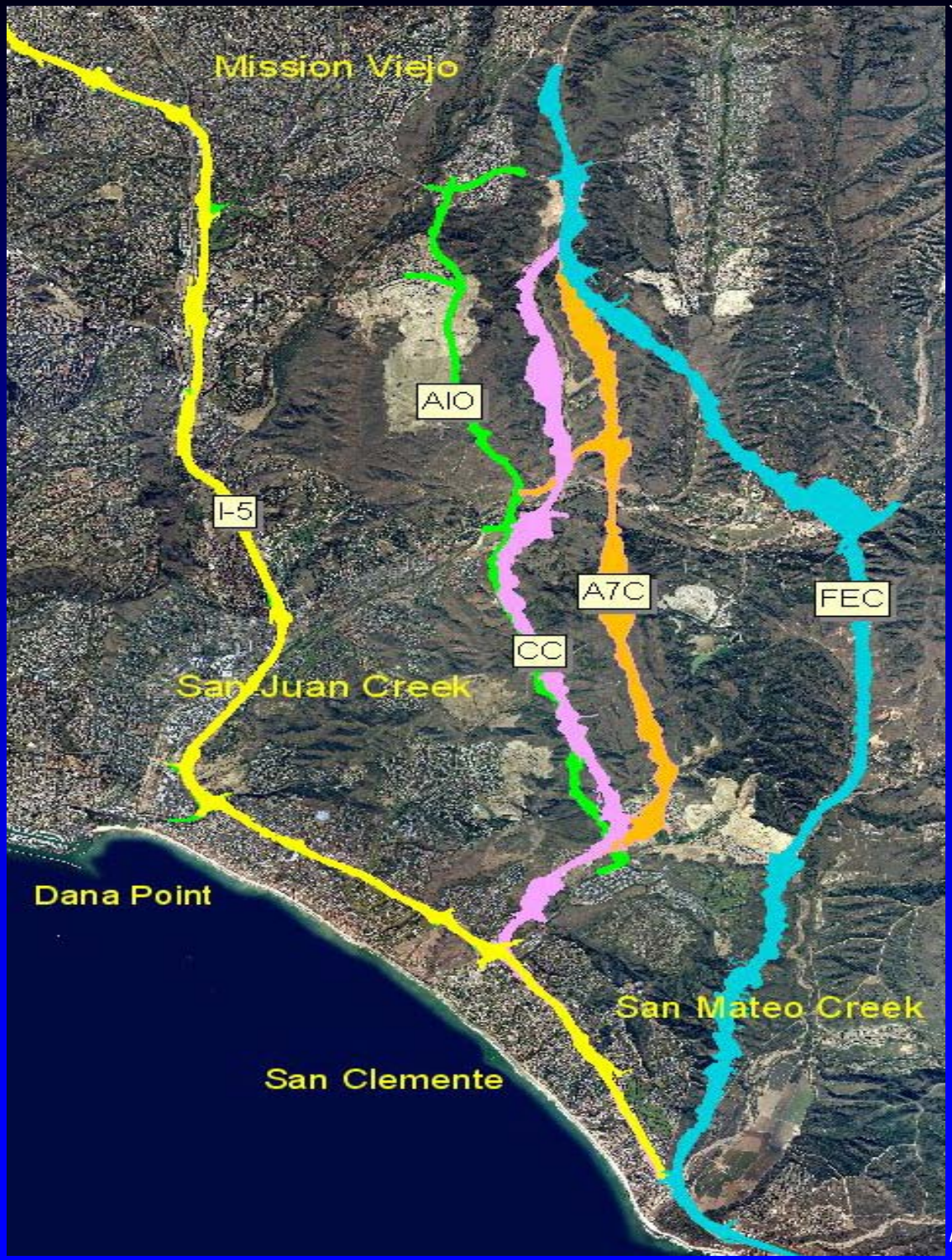
General Land Use Plan Alternative "Impact Area"

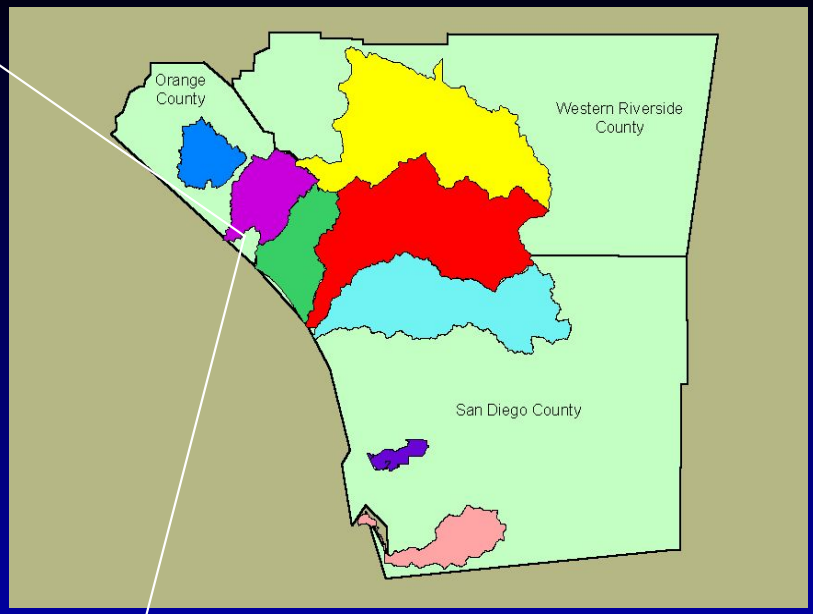
Preferred Alternative "Avoidance Area"



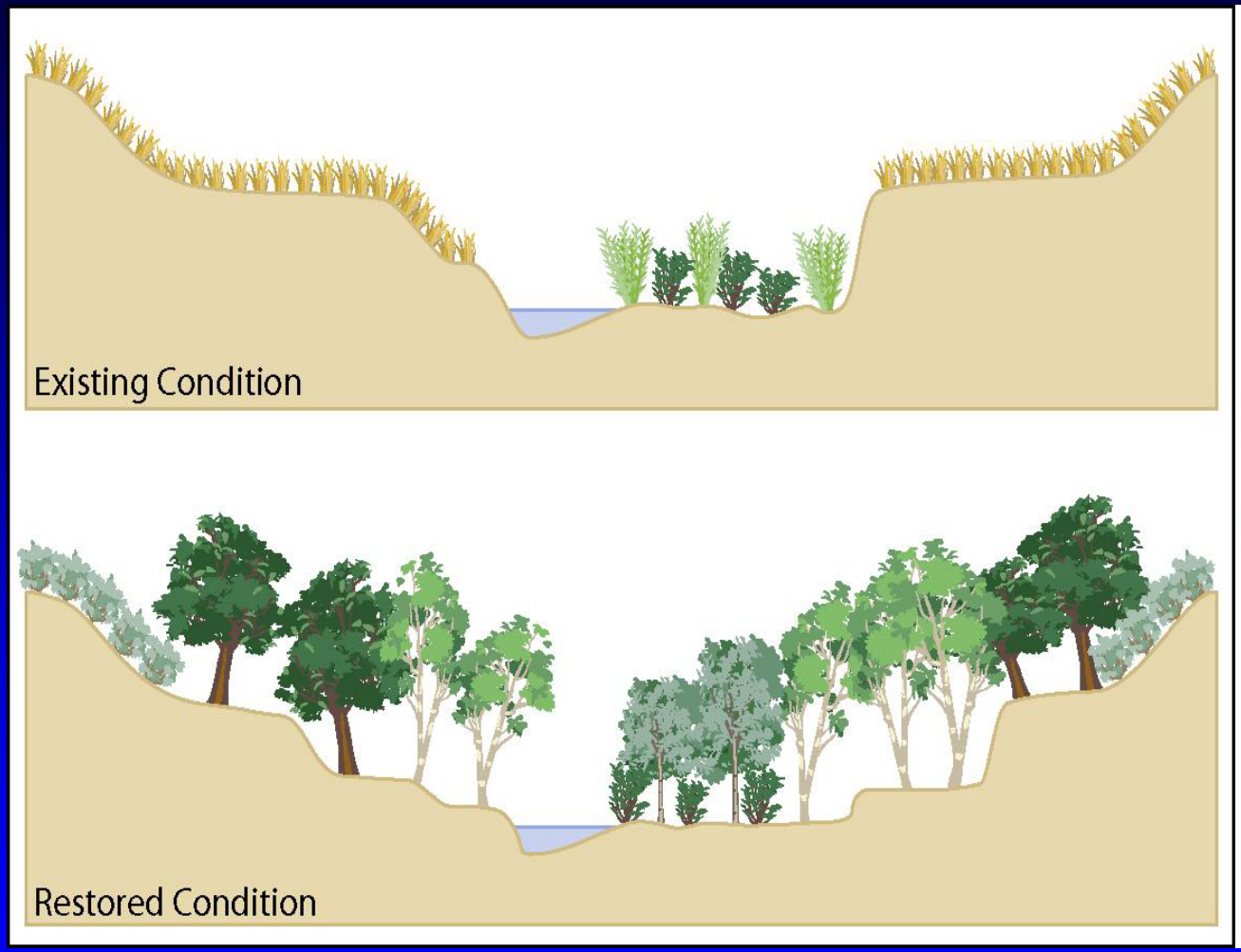
US Army Corps of Engineers

Engineer Research and Development Center


Mission Viejo
AIO
I-5
A7C
FEC
CC
San Juan Creek
Dana Point
San Mateo Creek
San Clemente


Orange County
Western Riverside County
San Diego County

Incised Restoration Template



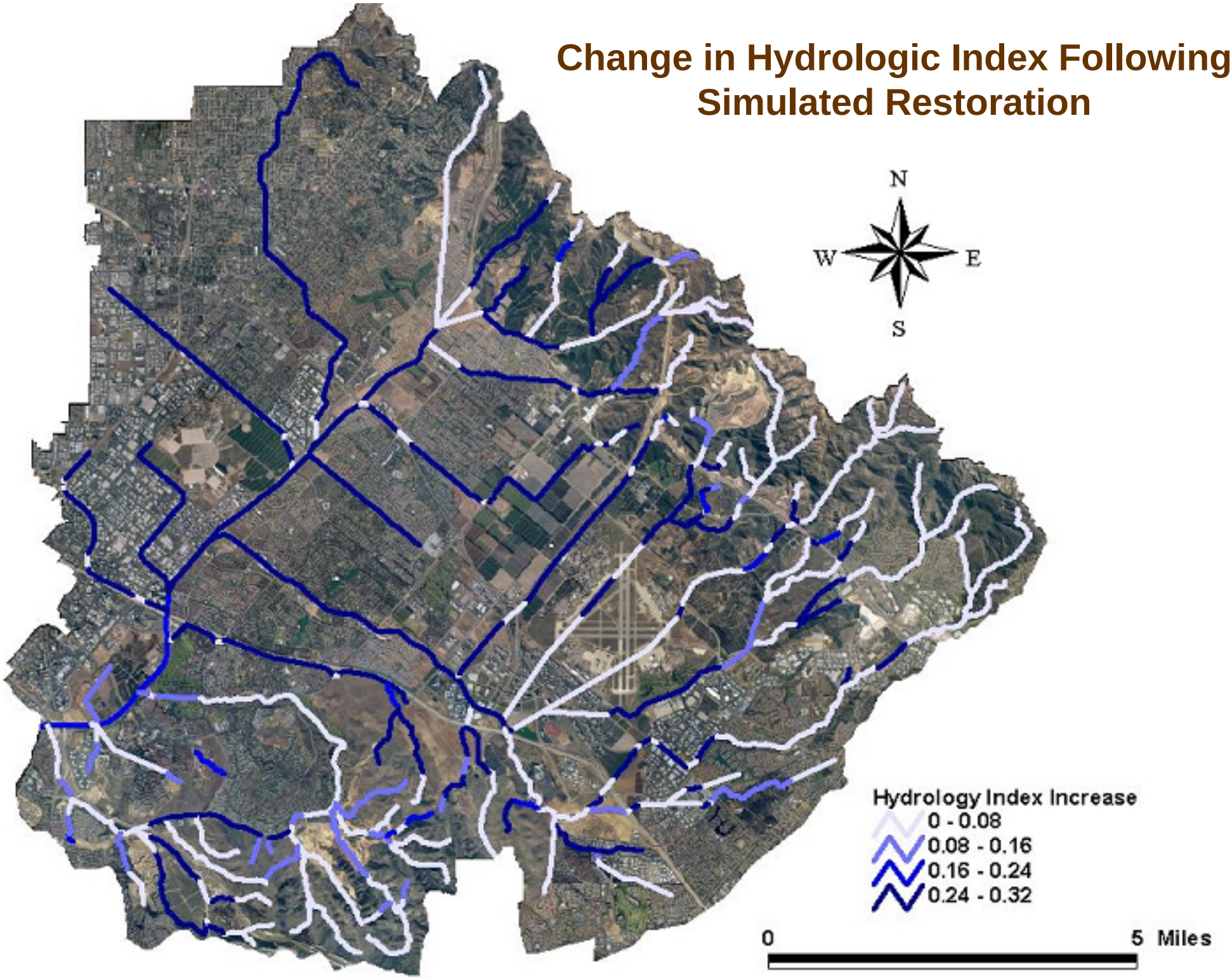
LEGEND

Characteristic Species/ Community Types

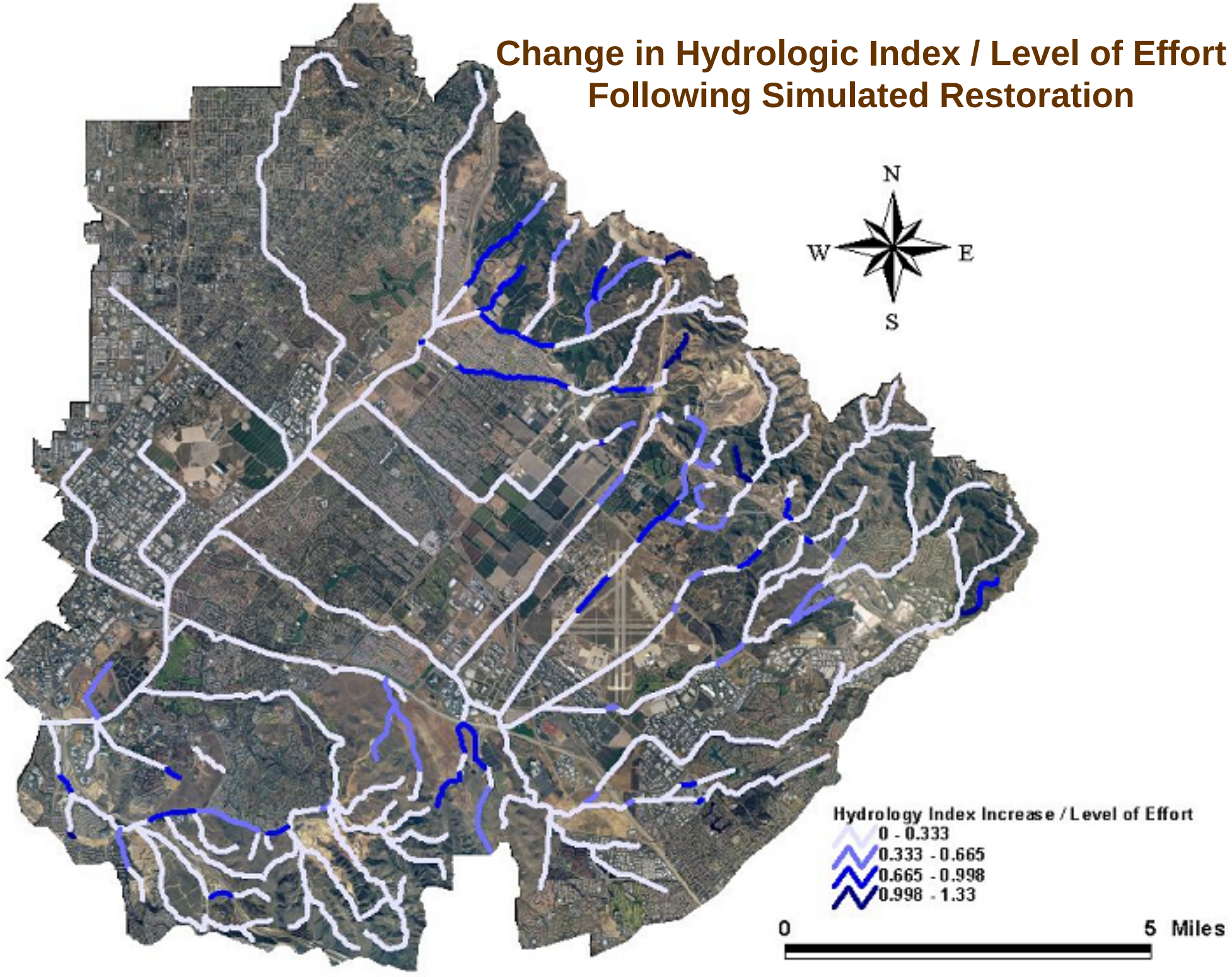
- Rangeland (annual grasses & forbs)
- Coastal sage-scrub or chaparral
- Oak woodland
- Sycamore
- Willow
- Mulefat
- Arundo and other exotics

- **Bankfull Width: 1.5 m**
- **Bankfull Depth: 0.15 m**
- **Flood Prone Width: 2.4 m**
- **First Terrace Width: 1.8 m**
- **Height above Bankfull: 0.45 m**
- **Second Terrace Width: NA**
- **Height Above Bankfull: NA**

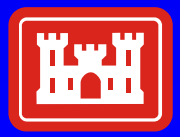
Change in Hydrologic Index Following Simulated Restoration



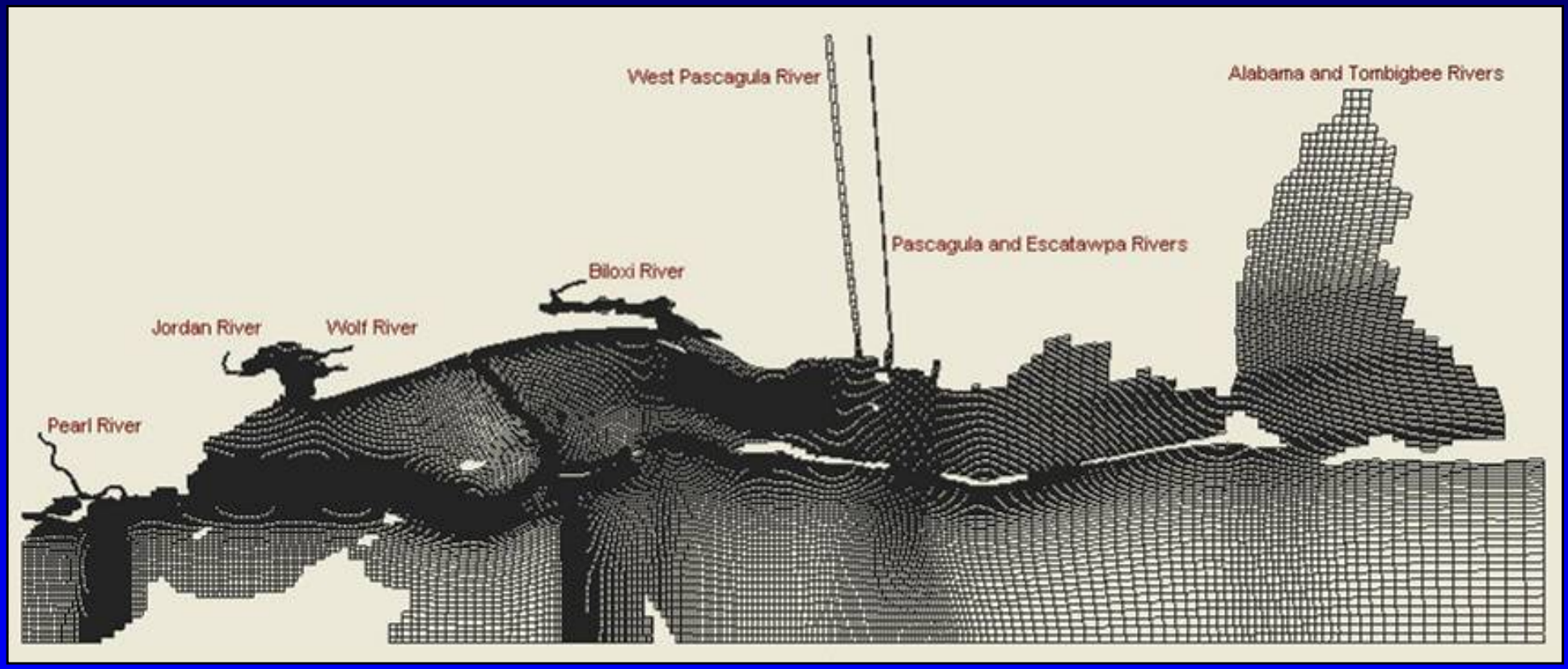
Change in Hydrologic Index / Level of Effort Following Simulated Restoration



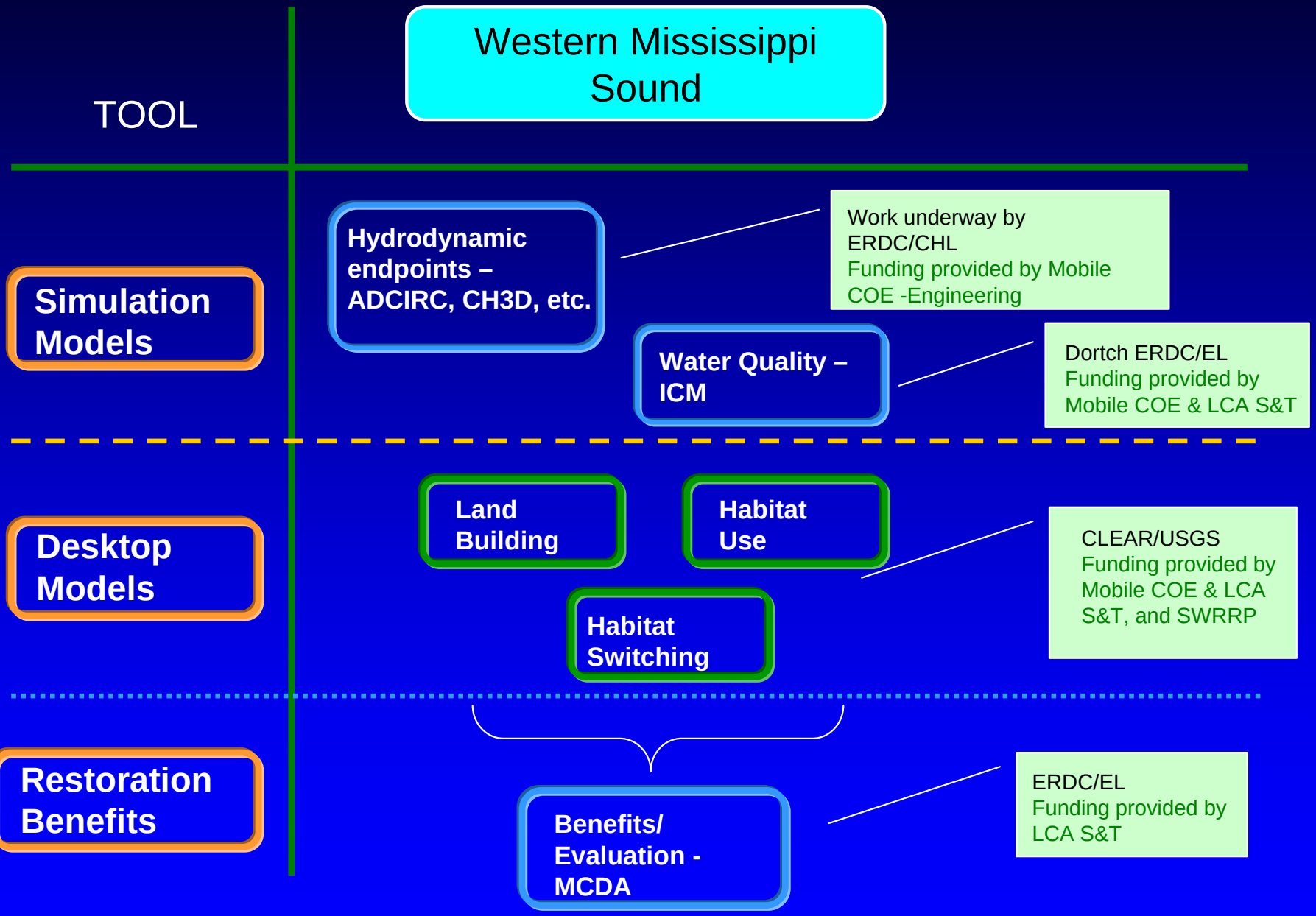
LCA and MsCIP: Effects of Freshwater Diversions on Western MS Sound



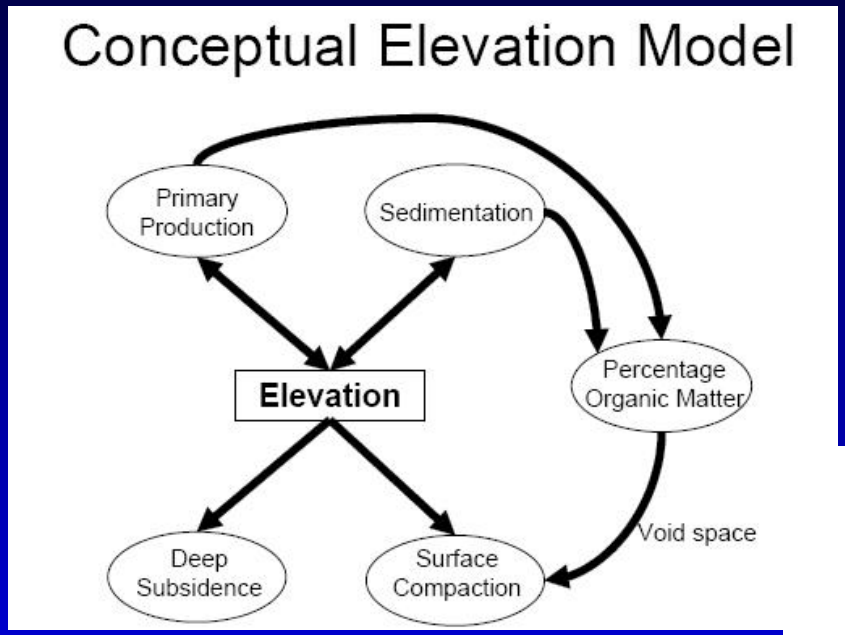
CH3D boundary-fitted coordinates grid for Mississippi Sound



Subprovince 0.5 or the LA/MS Area



Land Building



- Distance from river or diversion
- Sediment Load
- Decrease in salinity
- Marsh "nourishment"

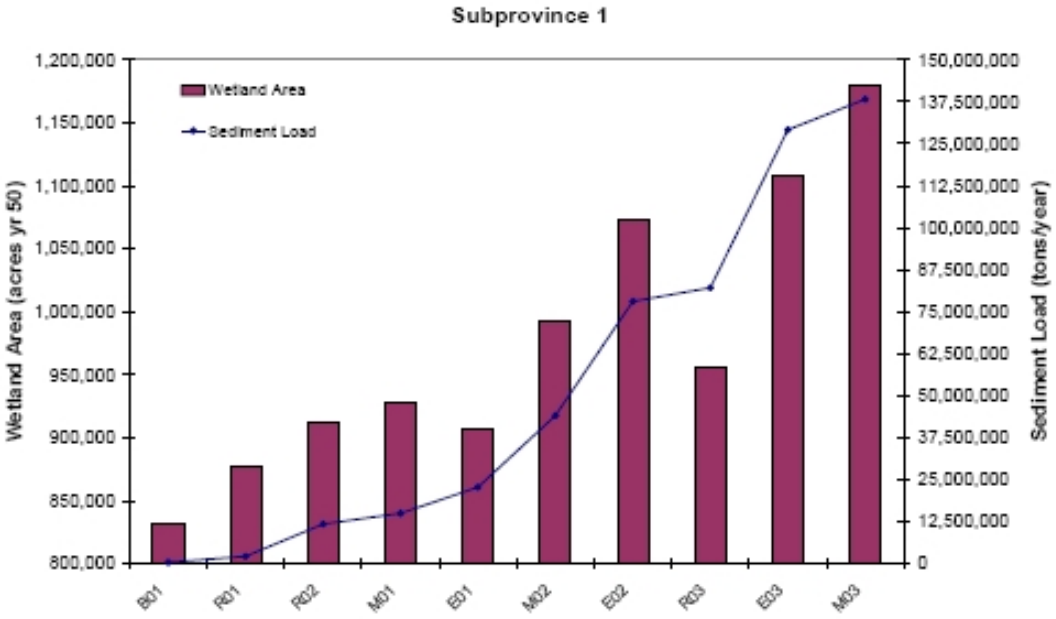


Figure C.8-9 Wetland area in Year 50 as a Result of Different Restoration Scenarios in Order of Increased Sediment Load

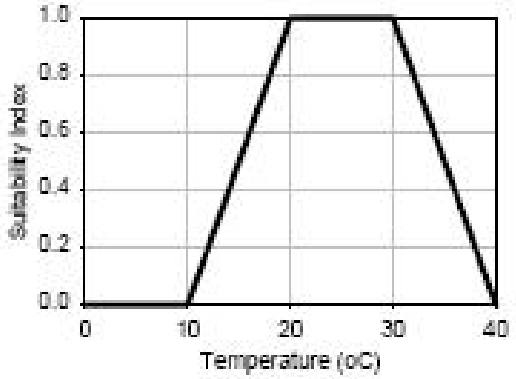
Habitat Use (White Shrimp)

V1 - percentage of km2 covered by marsh vegetation
V2 - mean salinity for summer (June, July, and August)
V3 - mean water temperature for summer (June, July, and August)

Suitability function for V1

$$SI_1 = \begin{cases} 0.036 \bullet V1 + 0.1 & \text{for } 0 < V1 \le 25 \\ 1.0 & \text{for } 25 < V1 \le 80 \\ 4.582 - 0.0448 \bullet V1 & \text{for } 80 < V1 \le 100 \end{cases}$$

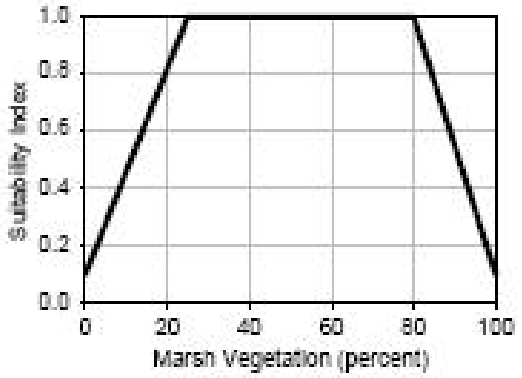
(White Shrimp)



Suitability function for V2

$$SI_2 = \begin{cases} V2 & \text{for } V2 \le 1 \\ 1.0 & \text{for } 1 < V2 \le 15 \\ 2.0 - 0.0667 \bullet V2 & \text{for } 15 < V2 < 30 \\ 0.0 & \text{for } V2 > 30 \end{cases}$$

(White Shrimp)



Habitat Switching

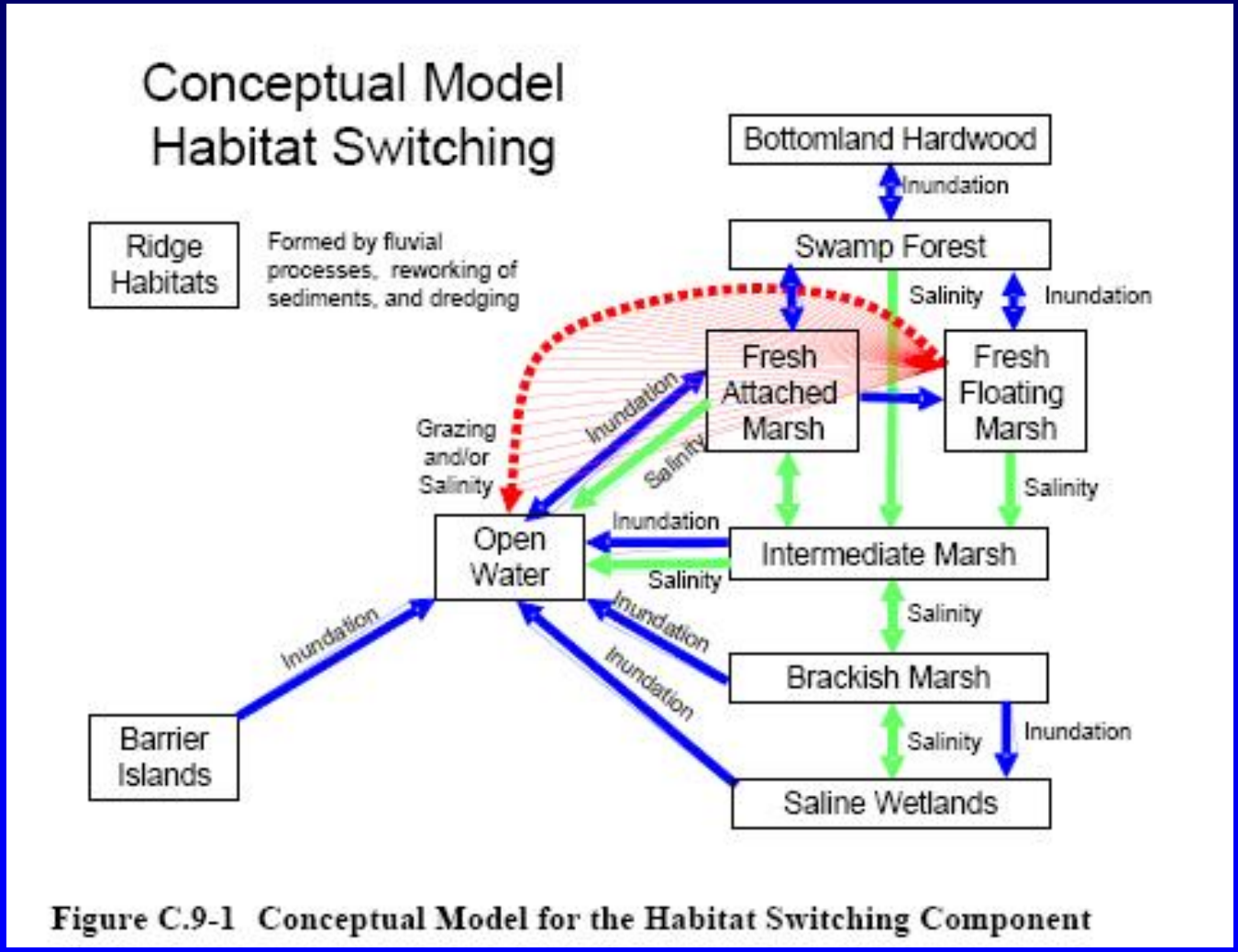


Figure C.9-1 Conceptual Model for the Habitat Switching Component

Scenario Comparisons

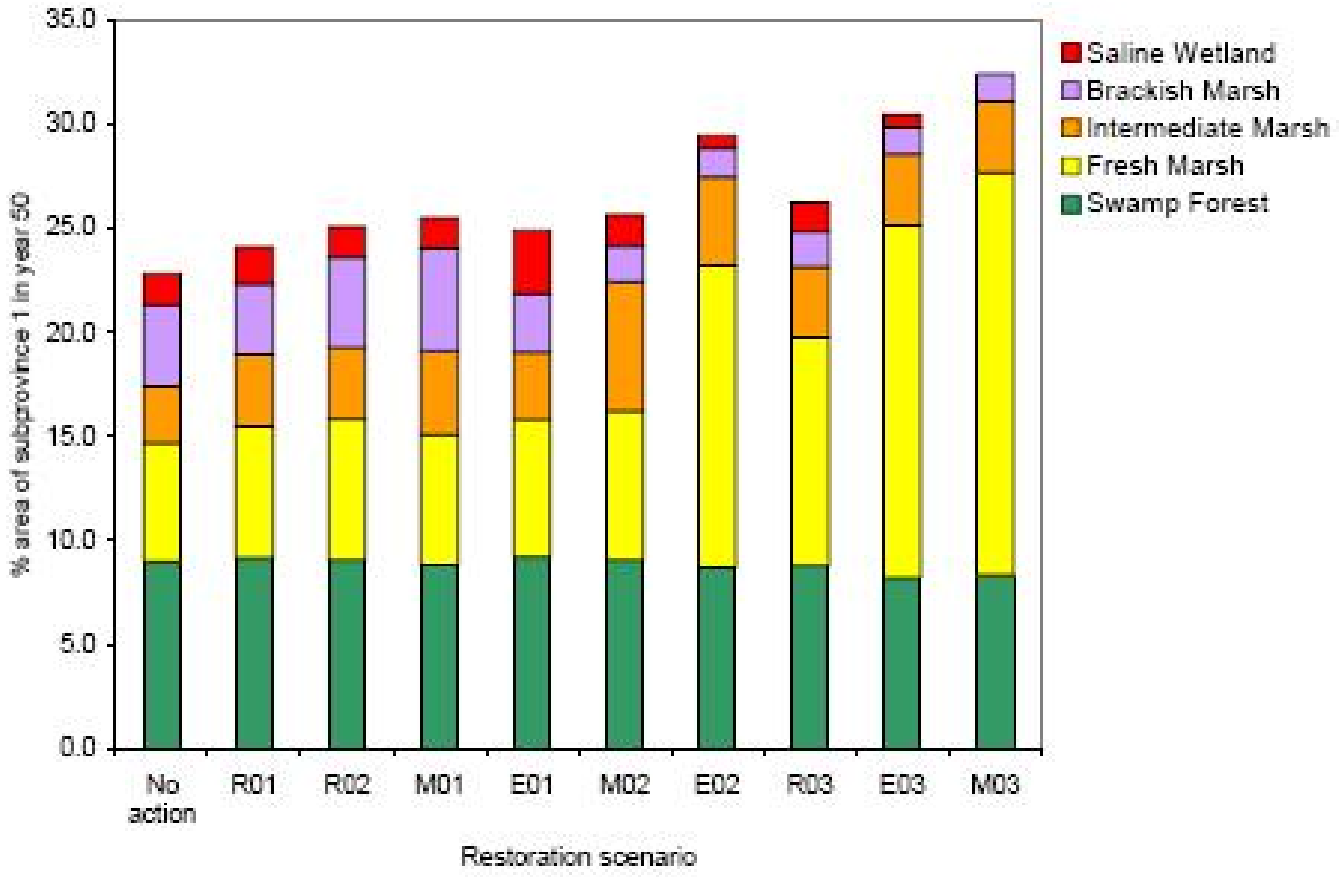


Figure C.9-7 Change in Habitat Composition Resulting from Different Restoration Scenarios